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Li-Fi

Our future wireless communication method

Contents

[Abstract 2](#_Toc438073802)

[Inquiry 3](#_Toc438073803)

[A brief on Wi-Fi 4](#_Toc438073804)

[Optical wireless communication. 5](#_Toc438073805)

[VLC (identification and basics) 5](#_Toc438073806)

[The most important characteristics of VLC. 6](#_Toc438073807)

[Communication with VLC 7](#_Toc438073808)

[What is Li-Fi? 7](#_Toc438073810)

[How does it work? 7](#_Toc438073811)

[Li-Fi CONSTRUCTION 9](#_Toc438073812)

[Advantages of Li-Fi 10](#_Toc438073813)

[Disadvantages of Li-Fi 10](#_Toc438073814)

[Comparing between Li-Fi & Wi-Fi 10](#_Toc438073815)

[Application on VLC and Li-Fi 12](#_Toc438073816)

[The conclusion 14](#_Toc438073817)

[The End 15](#_Toc438073818)

[Bibliography 16](#_Toc438073819)

[Li-Fi work 1](#_Toc438022309) 8

[Li-Fi construction 2 9](#_Toc438022310)

[comparision between Li-Fi & Wi-Fi 3](#_Toc438022311) 12

# Abstract

These days everyone is using internet throughout Wi-Fi connection and because of the huge increasing in utilization the Wi-Fi networks by millions of people around the world, these networks are put under big pressure to give high speeds. (So whether you are using wireless internet in a coffee shop, stealing it from the person next door, or competing for bandwidth at a conference, you have probably gotten frustrated at the slow speeds you face when more than one device is tapped into the network. As more and more people and their many devices access wireless internet, clogged airwaves are going to make it. One germen phycist.Harald Haas has come up with a solution he calls “data through illumination” –taking the fibber out of fiber optic by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. It is the same idea band behind infrared remote controls but far more powerful. Haas says his invention, which he calls D-LIGHT, can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection. He envisions a future where data for laptops, smart phones, and tablets is transmitted through the light in a room. In addition, security would be snap – if you cannot see the light, you cannot access the data)[[1]](#footnote-1).

# Inquiry

Therefore, in this research, we will show the method of Li-Fi and its advantages and disadvantages and the probability to implement it all over the world, and we will never forget the real origin of this technology, which is VLC technology. In addition to that, we will explain the basic scheme of this techno and what are the most dependences that it uses.

* A brief on Wi-Fi.
* VLC technology (the speediest way to share info around the world until now).
* Who is the founder of Li-Fi (Light Fidelity)?
* New techno Li-Fi (identification and basics).
* Merits and demerits of Li-Fi.
* Li-Fi challenges Wi-Fi and the other communication technologies in speed, healthy, and security.
* Comparing between Li-Fi & Wi-Fi.
* And another questions and problems we will explain later in this research such as the mode of using Li-Fi and the commercial economizing by replacing Wi-Fi with this techno etc……..

So I hope that you will find the benefit and fun in this research.

Best wishes.

Ali S.AL-ali.

# A brief on Wi-Fi

Wi-Fi is a communication method uses the radiation fidelity (RF) as a way to spread the information or the data that it is used for.

It named Wi-Fi as an abbreviation of wireless communication fidelity.

The highest speed that Wi-Fi can reach is about 150 megabytes; this speed is considered a slow speed now because of the massive utilization of Wi-Fi to connect to the internet by many devices (laptops, smartphones and Tablets).

So we extremely need another technology that can replace the Wi-Fi techno in a big difference in the speed.

# Optical wireless communication.

(Optical communication is any form of telecommunication that uses light as the transmission medium. Having originated in ancient times in the form of beacon ﬁres and smoke signals that convey a message, optical wireless communication (OWC) has evolved to a high-capacity complementary technology to radio frequency (RF) communication. OWC systems utilize wavelengths in the infrared (IR) spectrum for IR communication and the visible light spectrum for visible light communication (VLC). Because of the availability of a huge license-free spectrum of approximately 670 THz, OWC has the potential to provide wireless links with very high data rates)[[2]](#footnote-2).

## VLC (identification and basics)

(Communication with light has long history. Photo phone was the first experiment of VLC done by Graham Bell in 1880.Visible light communication is a data communication medium using visible light as carrier. It is one of the parts of optical wireless communication (OWC). Optical communication becomes cost effective because of the use of light which if freely available everywhere. The visible light communication is done with LED. The intensity of light is modulated such that a human eye cannot follow it. A light detector with interference prevention from other source is used. It is acting as receiver, which can demodulate the light signal into electronic signal. It difference from infrared (IR) and ultra violet (UV) as light used for lightning is also used for communication.

VLC is mostly used for indoor communication. The most important requirement is of light source with ability of very fast on-off switching. A novel modulation technique like unipolar orthogonal frequency division multiplexing (UOFDM) is used. Visible light is constant beam of photons emitted from light source when constant current is applied. When the

Current varied at very high speed, light output varies accordingly, which is detected by photo detector (PD).

VLC data flow these variations in light are impossible to follow by human eyes. Hence, we feel constant lightning from light source. VLC is much simpler than complex RF communication like IR, which is limited in power because of its hazardous effects. Li-fi technology uses VLC. It is similar to Wi-Fi technology with RF communication. The term Li-fi was first coined by Harald Haas, a German physicist. Li-fi operates in the range of terahertz and it is free from the spectrum license).

## The most important characteristics of VLC.

1. Spectrum availability

VLC uses visible light region of electromagnetic spectrum, which is 10,000-time border than established RF.

Communication. The frequency band for visible light is 430-790 THz and for RF it is 3-300 GHz. Hence, VLC is the best solution to fill the gap between user demand and network capacity.

1. Safety

 VLC uses light as a carrier. Light is the source of life. Hence, there has no health hazard. While in case of RF, it is proved hazardous for all living things.

1. Efficiency

 VLC provides efficient way of communication due LED which require negligible power and less complexity. It is inexpensive because of the use of already available visible light sources. In case of RF communication, complexity and cost is very high.

1. Security

VLC is secure because of two main reasons: VLC signal is defined closely to lightning area i.e. line of sight communication and other is signals cannot be transmitted through solid things like walls.

1. Unlicensed use.

 As VLC uses visible spectrum that is free. Hence, there are no licensing issues.

1. High data rates.

 VLC inherits high data rates from optical communication)[[3]](#footnote-3).

## Communication with VLC

## (For any communication, the two basic parts are sender and receiver. In VLC, a LED bulb is used as sender. The sender signal is controlled either by fast ON/OFF switching of LED or by color of light. This flickering is not good for eye safety; hence, a dimming scheme LED illumination or modulation is used control brightness. The photo diode is used as a receiver to detect this signal)[[4]](#footnote-4).

# What is Li-Fi?

(LiFi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow.Li-Fi is the term some have used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. The term was first used in this context by Harald Haas in his TED Global talk on Visible Light Communication. “At the heart of this technology is a new generation of high brightness light-emitting diodes”, says Harald Haas from the University of Edinburgh, UK,”Very simply, if the LED is on, you transmit a digital 1, if it’s off you transmit a 0,”Haas says, “They can be switched on and off very quickly or simply by changing the light color, which gives nice opportunities for transmitted data.” It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s.The LED intensity is modulated so rapidly that human eye cannot notice, so the output appears constant. More sophisticated techniques could dramatically increase VLC data rate)[[5]](#footnote-5).

## How does it work?

(Standard LED light bulbs are controlled by a driver that turns the LED on and off or dims and brightens it. With Li-Fi enabled LED light bulbs, the driver is used to transmit encoded data by controlling the LED light. An optical sensor is used to receive the data, which is then decoded. This is conceptually similar to Morse code – but at rates of many millions of times a second, which is unperceivable to the human eye.

The receiver has optics, and is fast enough to ‘see’ the light dimming and brightening, smart enough to decode the Li-Fi data, and then deliver it to the attached device such as a laptop computer.

Devices can include both a transmitter and receiver to enjoy two-way communications)[[6]](#footnote-6).



1(Li-Fi works)

##

## Li-Fi CONSTRUCTION

(The Li-Fi product consists of four primary sub-assemblies:

 • Bulb

 • RF power amplifier circuit (PA)

 • Printed circuit board (PCB)

• Enclosure

The PCB controls the electrical inputs and outputs of the lamp and houses the microcontroller used to manage different lamp functions. An RF (radio frequency) signal is generated by the solid-state PA and is guided into an electric field about the bulb. The high concentration of energy in the electric field vaporizes the contents of the bulb to a plasma state at the bulb’s center; this controlled plasma generates an intense source of light. All of these subassemblies are contained in an aluminum enclosure)[[7]](#footnote-7).

 2(Li-Fi construction)

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## Advantages of Li-Fi

(1. Radio waves are harmful for human beings as they penetrate the body and may cause mutation. Therefore, it is safe.

2. It is very secure (no-body can hack it,) since no signal penetration through walls.

3. Tremendous data transfer rates.

4. It works under water, so it is beneficial in many fields. Because of these advantages, wireless technology is going to hit an upper level.

## Disadvantages of Li-Fi

1. These signals cannot penetrate walls. Therefore, the person needs wired bulb in that room also.

2. Only works if there is direct line of sight between source and receiver)[[8]](#footnote-8).

# Comparing between Li-Fi & Wi-Fi

(LI-FI is a term of one used to describe visible light communication technology applied to high-speed wireless communication. It acquired this name due to the similarity to WI-FI, only using light instead of radio. WI-FI is great for general wireless coverage within buildings, and li-fi is ideal for high-density wireless data coverage in confined area and for relieving radio interference issues, so the two technologies can be considered complimentary.

Li-Fi can turn an LED lamp into a wireless access point similar to a Wi-Fi router, so apart from the added advantage of illumination, how do they differ? 

“CONGESTION”

 Wi-Fi uses radio frequencies, and these are very limited. Devices – computers, laptops, printers, smart TVs, smartphones and tablets – must compete for bandwidth. The emergence of more and more WiFi-enabled things e.g. refrigerators, watches, cameras, and offloading from cellular is causing congestion, and degrading data communications. Li-Fi uses the frequencies of light waves, which are up to 10,000 times more plentiful than radio frequencies and do not compete with Wi-Fi.

“SAFETY”

Wi-Fi creates Electromagnetic Interference (EMI), known to interfere with airplanes’ instruments and equipment in hospitals, and is potentially dangerous in hazardous operations, such as power/nuclear generation or oil and gas drilling. Li-Fi uses light instead of radio waves, which is intrinsically safe and does not create EMI.

“SECURITY”

 Radio waves pass through walls and ceilings. Light does not. Therein lies the difference in data security between Wi-Fi and Li-Fi. An intruder or hacker, outside a building can tap into the Wi-Fi data communications of computers inside the building. Data communicated via LiFi can only be accessed where the LED light illuminates.

“SPEED” 

Wi-Fi standard, 802.11a/g provides data communication rates up to 54Mbps. However, there are techniques available to extend this to 1Gbps. The University of Edinburgh, pureVLC's partner and home to Prof. Harald Haas – “the father of Li-Fi” have already demonstrated 3Gbps on a single color. On a single LED with full color (R, G, B) this could communicate at speeds up to 9Gbps)[[9]](#footnote-9).



 3(comparison between Li-Fi & Wi-Fi)

# Application on VLC and Li-Fi

1. (Aviation

Any RF operated gadget is not allowed in passenger aircraft. Here LED’s can perform dual function of illumination and communication.

1. Vehicle transportation

 Vehicles with tail and head LED lamp can act as a transmitter and receiver for VLC communication. It will be easy to convey any message regarding traffic to vehicles. Efficient intra-vehicle communication is possible. Traffic control becomes easier.

1. Healthcare

In hospitals any RF application like Wi-Fi is banned because of its hazardous effects on human health, it may affect the working of medical instruments. In this situation, Li-Fi which uses light as medium will be best solution for communication in hospital campus.

1. Defense

With established RF application, it is not possible to communicate without proper instruments. As light is available everywhere, VLC communication is possible. Like RF jammer, VLC communication has no such barrier.

1. Industrial

RF communication is dangerous in areas with burnable materials like mines, petrochemical, power plants and petrol pumps. Here, Li-Fi can be used as safe alternative.

6. Underwater communication

Underwater RF communication is extremely difficult, but with VLC, it is much easier.

 7. Commercial

VLC tags, ID’s can be used in malls for localization and positioning purpose)[[10]](#footnote-10).

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# The conclusion

As a conclusion in the end of the research, we found that Li-Fi technology is better than Wi-Fi in many ways like (safety, bandwidth, and speed).

So we can use Li-Fi technology in different fields like hospitals because it is safe unlike Wi-Fi which is damaging the human beings because its RF fidelity,

Moreover, we can use it underwater to communicate with submarines unlike Wi-Fi, which cannot through the water.

Also in the smarter power plants, (as we know that the Wi-Fi and the other radiation types are bad for the sensitive areas like nuclear regions which demand a high speed internet connection to monitoring the grid integrity and the temperature of (nuclear plants) core.

In addition, we can use it in the airlines as a luxury or welfare for the passengers who cannot use Wi-Fi connection because its bad Radiation effect on the plane system so Li-Fi because of its light demanding it does not interrupt with the plane system.

And we can use it everywhere at the work, in the cars, under streetlights and finally in this techno we use the highest, cleanest, speediest and brightest source of the internet connection all over the world until now.

# The End

At the end of this research, I want to suggest that we can develop this techno and use it all over the world because of its inexpensive cost and simple equipment that it is available in everywhere for everybody.

Even we can use the VLC to develop another way of communication can be more effective.

Finally I want to present this work for the NCD which develops our capabilities in ever field we love and for the Syrian Arab Army who protect us in every second in everywhere.

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